

Osmosis and Diffusion Lab Activity



DID YOU KNOW?

Osmosis is fundamental in many industrial processes such as water purification, desalination, and waste material treatment.



DID YOU KNOW?

Absolute zero, or zero degrees Kelvin, is the point at which molecules have no kinetic energy and therefore stand completely still.

Membranes surround cells and cellular organelles. These membranes act as “gateways” between the outside environment and a cell’s cytoplasm. Membranes are very important to the function of the cell, and allow only certain molecules to enter and exit the cytoplasm freely. Because the cell’s membrane is more permeable to some substances than others, it is said to be selectively permeable.

In 1827, Scottish scientist Robert Brown found that tiny particles suspended in water moved in small, quick movements. This phenomenon is known as Brownian movement or random motion. Molecules exhibit random motion in all liquids and gases; that is, they move in an undirected fashion, bouncing off other molecules.

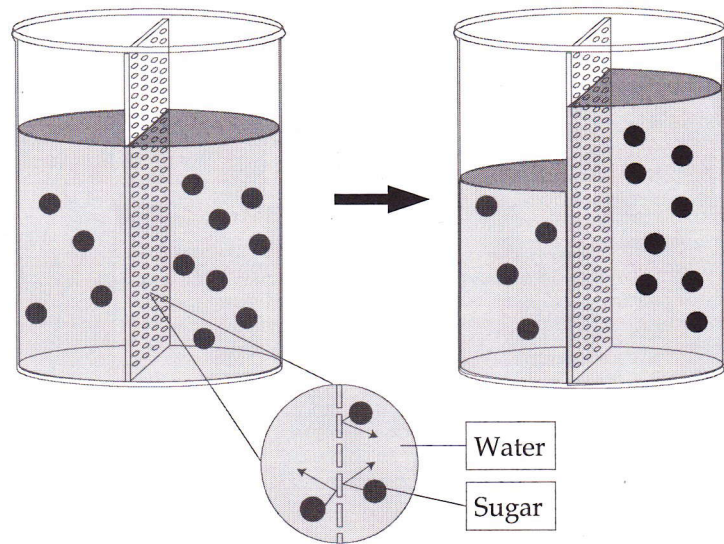
Diffusion is the movement of molecules from an area of high concentration to an area of lower concentration. Since molecules are in constant motion, they will bounce off each other and flow toward an area of fewer molecules (low concentration).

The difference between molecules of high concentration and low concentration is called a concentration gradient. When a concentration gradient exists (a higher concentration exists in one area and a low concentration exists in another), diffusion will take place and molecules will move until equilibrium of molecules exists across the gradient. For example, when a bottle of hydrogen sulfide (which gives off a smell of rotten eggs) is opened on one side of a room, the smell will quickly be detected on the other side. The bottle has a high concentration of hydrogen sulfide; the room has a low concentration. The hydrogen sulfide will diffuse to the less concentrated area until equilibrium is found.

Osmosis is a process by which water moves through a selectively permeable membrane. The osmotic process is a special case of diffusion involving the diffusion of a solvent, such as water, rather than the diffusion of substances (solutes) dissolved in the solvent.

Osmosis takes place whenever there is an unequal concentration of water on either side of a selectively permeable membrane. Water will continue to move across the concentration gradient until equilibrium occurs.

Figure 1



DID YOU KNOW?

Part of the process for freezing human eggs includes immersing the eggs in a sucrose solution to draw the water out of the eggs through osmosis.

Water molecules are in constant motion, and act in the same manner as other molecules, moving from an area of high concentration through a membrane to an area of low concentration. In some cases, the cell must transport substances in and out of its cell membrane, acting against a concentration gradient. For this process of active transport, the cell uses energy derived from ATP or a protein to move solutes into or out of the cell. Since dialysis tubing is not living and does not produce ATP, this process cannot be shown here.

OBJECTIVES

- Demonstrate osmosis and diffusion of molecules through a selectively permeable membrane.
- Determine which molecules are able to pass through a membrane and which molecules are not able to pass.
- Describe the effects of solute concentration on diffusion and osmosis across a selectively permeable membrane



DID YOU KNOW?

Frogs never drink water. They absorb water from their environment through the process of osmosis.

Exercise A: Diffusion



DID YOU KNOW?

Several sea-going birds, such as penguins and sea gulls, can drink salt water. They have special glands in their heads that remove and excrete salt, making it useful for consumption.

MATERIALS

Materials needed per group

- 1 Cup
- 4 Glucose testing strips
- 1 One-foot section of dialysis tubing

Shared materials

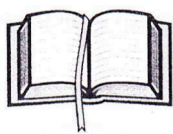
Graduated cylinder
Glucose/Starch solution
Iodine potassium iodide (IKI)

PROCEDURES

1. Pour 15 ml of prepared glucose/starch solution into a graduated cylinder.
2. Determine if glucose is present in the prepared solution by dipping a glucose indicator strip into the solution. Record the data in Table 1 (write “yes” if glucose is present or “no” if glucose is not present) under “Glucose Content-Dialysis Bag”.
3. Obtain a piece of dialysis tubing from the beaker of water. Fold one end of the dialysis tubing and place the dialysis tube clip over the folded end of the tubing and clip into place.

The pores of the dialysis tubing are extremely small, and can be easily clogged by any oil or dirt on your fingers and hands. Keep physical contact with the tubing to a minimum.

4. Open the tubing by rubbing the unclipped end between your fingers. Pour 15 ml of the glucose/starch solution into the tubing.
5. Note the color of the solution in the bag. Record the color in Table 1 under “Color-Dialysis Bag”.
6. Fold the open end of the tubing and place another dialysis tube clip as before. Be sure to leave enough room for expansion.
7. Fill a plastic cup approximately 2/3 full with water. Add 1 eye-dropper full of IKI (Potassium Iodine) to the water in the cup. Gently stir the solution until you have an even mixture.



Solute:

The constituent of a solution that is dissolved in the solvent.

Solvent:

The constituent of a solution that dissolves the solute.

Concentration:

The ratio of the mass or volume of a solute to the mass or volume of the solvent.



DID YOU KNOW?

Osmosis is a reversible thermodynamic process. In other words, the direction of water flow through a membrane can be reversed at any time by proper control of the external pressure on the solution.

The IKI solution is an irritant; it affects skin and eyes, and can stain clothing. Handle the solution with caution. Wash off spills and splashes with water.

8. Note the color of the solution. Record the color in Table 1 under "Color-Cup".
9. Determine if glucose is present in the IKI solution by dipping a glucose indicator strip into the cup. Record the data in Table 1 (write "yes" if glucose is present or "no" if glucose is not present) under "Glucose Content-Cup".
10. Completely immerse the dialysis bag in the solution in the cup.
11. Wait 30 minutes.
12. While your waiting move onto Exercise B: Osmosis of Potato Cores. Complete steps 1-6 for the beaker contents that you have been assigned.
13. After 30 minutes remove the dialysis bag from the cup. Record the final color of the solutions in the bag and the cup in Table 1.
14. Determine the glucose content in the cup and in the dialysis bag by using glucose indicator strips. To test the solution in the bag, unclip the bag, and insert the indicator strip into the solution. Record the data in Table 1.
15. Complete the analysis section for Exercise A

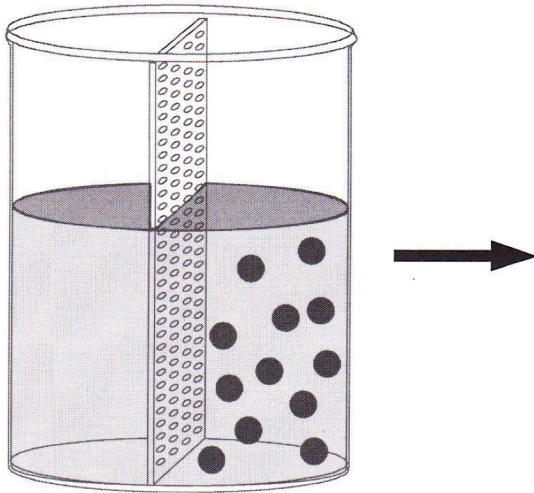
Clean up all materials and dispose of them according to your teachers instructions. Be sure to wash your hands thoroughly before leaving the laboratory.

Table 1
Diffusion

	Color		Glucose Content	
	Dialysis Bag	Cup	Dialysis Bag	Cup
Start				
30 minutes				

Analysis Exercise A: Diffusion

1. Below is a diagram of a chamber separated by a semi-permeable membrane. One side contains a mixture of molecules in water and the other side contains only water. In the space next to the picture, draw what you think the chamber would look like after an extended period of time.



2. How can you determine whether the following molecules are present:

a. Starch

b. Glucose

3. IKI (iodine potassium iodide), when mixed with starch, reacts to cause a color change from clear to a blue/black. Glucose test strips are impregnated with a chemical that will change color when exposed to glucose. Given this information, answer the following questions:

a. Did the IKI enter, leave, or stay outside the “cell”? What evidence do you have to support your explanation?

b. Did the starch enter, leave, or stay inside the “cell”? What evidence do you have to support your explanation?

c. Did the glucose enter, leave, or stay inside the “cell”? What evidence do you have to support your explanation?

4. What is osmosis? Was there any evidence that osmosis occurred through the dialysis tubing? If yes, what evidence do you have to support your explanation? If no, explain how the experiment could be changed to allow for evidence to be collected to show osmosis occurred.

5. Molecules of a similar substance are about the same size, whereas molecules of different substances are known to have different sizes. By looking at your results, can you determine the relative sizes of molecules that did or did not diffuse across the dialysis membrane? If yes, list them in order from largest to smallest.

6. Can it be said that the dialysis membrane is similar to a plasma membrane? Explain.

7. Predict what would happen if you allowed the dialysis tubing to sit in the cup overnight. Explain.

Exercise B: Osmosis in Potato Cores

MATERIALS

Cork Borer
Potato
Electronic Scale
Cup Solutions
0.0 M Sucrose (distilled water)
0.2 M Sucrose
0.4 M Sucrose
0.6 M Sucrose
0.8 M Sucrose
1.0 M Sucrose

PROCEDURES

1. Pour 50 mL of each of the above solutions into the appropriately labeled plastic cups.
2. Use a cork borer to cut four potato cylinders. Do not include any skin on the cylinders. You need four potato cylinders for *each* cup.
3. Keep your potato cylinders in a covered cup until it is your turn to use the electron scale.
4. Determine the mass of the four cylinders together and record your initial mass in Table 2. Put the four cylinders into the beaker of sucrose solution.
5. Cover the beaker with a plastic lid to prevent evaporation. Take note of what group number you are that is written on the top of the plastic lid.
6. Let it stand overnight.
7. Remove the cores from the beakers, blot them gently on a paper towel, and determine their total mass.
8. Record the final masses in Table 2.
9. Calculate the percent change in mass for the class data using the following equation:

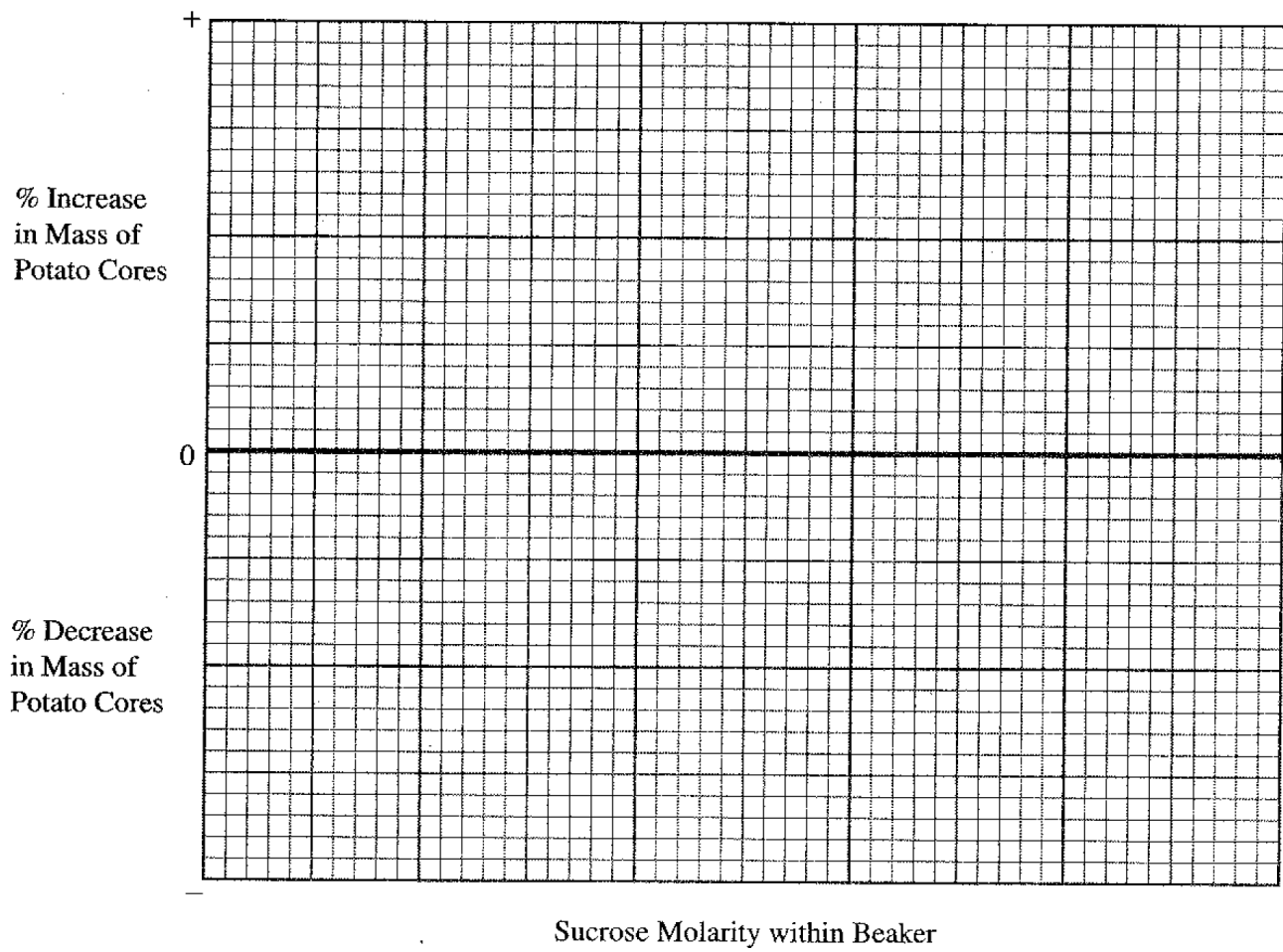
$$\text{Percent change in Mass} = \frac{\text{Final Mass} - \text{Initial Mass}}{\text{Initial Mass}} \times 100$$

10. Graph the percent change in mass data.

Table 2
Potato Core Data

% Sucrose in Cup	Initial Mass	Final Mass	Mass Difference	Percent Change in Mass
0% Sucrose				
2% Sucrose				
4% Sucrose				
6% Sucrose				
8% Sucrose				
10% Sucrose				

Percent Change in Mass of Potato Cores at Different Concentrations of Sucrose



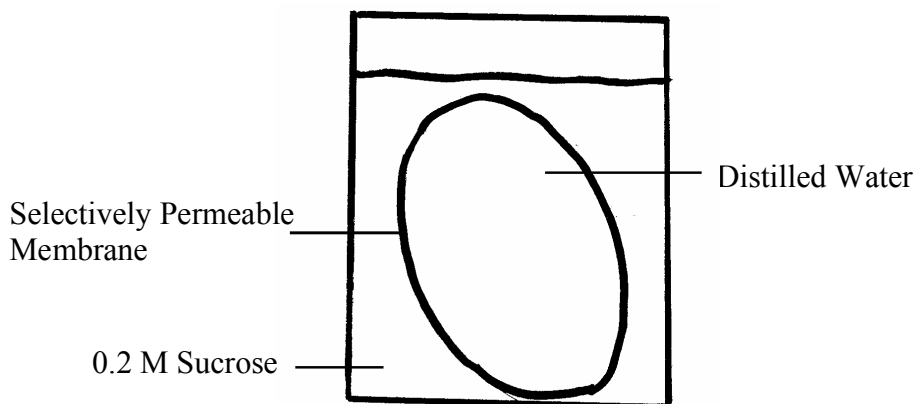
Exercise C: Osmosis

In this experiment you will use dialysis tubing to investigate the relationship between solute concentration and the movement of water through a selectively permeable membrane by the process of osmosis.

When two solutions have the same concentration of solutes, they are said to be **isotonic** to each other. If the two solutions differ in the concentration of solutes that each has, the one with more solute is **hypertonic** to the one with less solute. The solution that has less solute is **hypotonic** to the one with more solute. These two words can only be used to compare solutions.

Now consider two solutions separated by a selectively permeable membrane. The solution that is hypertonic to the other must have more solute and therefore less water. The water concentration of the hypertonic solution is less than the water concentration of the hypotonic solution, so the movement of water will be from the hypotonic solution into the hypertonic solution.

Label the sketch below to indicate which solution is hypertonic and which is hypotonic, and use arrows to show the initial movement of water.



MATERIAL

Material Needed Per Group

- 6 strips dialysis tubing
- 12 dialysis tubing clips
- 6 cups labeled as followed
 - 0.0 M Distilled H₂O
 - 0.2 M Sucrose
 - 0.4 M Sucrose
 - 0.6 M Sucrose
 - 0.8 M Sucrose
 - 1.0 M Sucrose

PROCEDURE

1. Obtain six strips of presoaked dialysis tubing.

2. Clip one end of each piece of dialysis tubing to form 6 bags. Pour approximately 20 mL of each of the following solutions into separate bags:

- a) 0.0 M distilled water
- b) 0.2 M sucrose
- c) 0.4 M sucrose
- d) 0.6 M sucrose
- e) 0.8 M sucrose
- f) 1.0 M sucrose

Remove most of the air from each bag by drawing the dialysis bag between two fingers. Clip the other end of the bag. Leave sufficient space for the expansion of the contents in the bag. (The solution should fill only about one-third to one-half of the piece of tubing.)

3. Rinse each bag gently with water to remove any sucrose spilled during filling.
4. Carefully blot the outside of each bag, mass each bag, and record in Table 3 the initial mass of each bag, expressed in grams.
5. Place all the bags in the large plastic cup.
6. Now fill the cup with distilled water until all the bags are covered with water. *Be sure to completely submerge each bag.*
7. Let them stand for 30 minutes.
8. At the end of 30 minutes remove the bags from the water. Carefully blot and determine the mass of each bag.
9. Record your data in Table 3.

Table 3
Dialysis Bag Results – Group Data

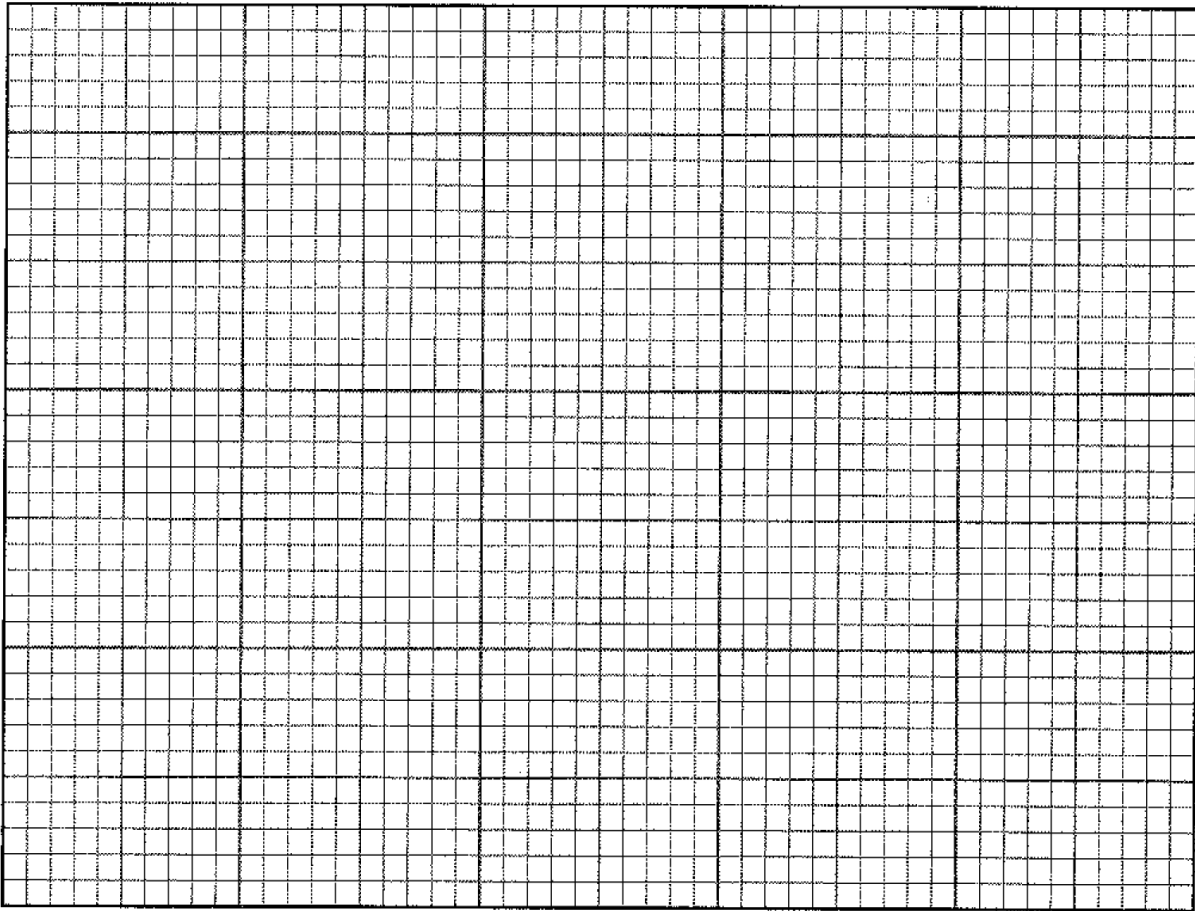
Contents in Dialysis Bag	Initial Mass	Final Mass	Mass Difference	Percent Change In Mass
0.0 M Distilled Water				
0.2 M Sucrose				
0.4 M Sucrose				
0.6 M Sucrose				
0.8 M Sucrose				
1.0 M Sucrose				

10. Graph the percent change in mass results from Table 3

For this graph you will need to determine the following:

- a) The independent variable: _____
Use this to label the horizontal (x) axis.
- b) The dependent variable: _____
Use this to label the vertical (y) axis.

Graph Title: _____



Analysis Exercise C: Osmosis

1. Explain the relationship between the change in mass and the concentration of sucrose within the dialysis bags.

2. Predict what would happen to the mass of **each** bag in this experiment if all the bags were placed in 0.4 M sucrose solution instead of distilled water. Explain your response.

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are approximately 20 lines visible. The paper has a slight shadow on the right side, suggesting it's resting on a surface.

3. Why did you calculate the percent change in mass rather than simply using the change in mass?

4. A dialysis bag is filled with distilled water and the placed in a sucrose solution. The bag's initial mass is 20g and its final mass is 18g. Calculate the percent change of mass, showing your calculations here.